Point-by-point response to review comments on manuscript amt-2016-116 "Inter-comparison of NIOSH and IMPROVE protocols for OC and EC determination: Implications for inter-protocol data conversion"

By Cheng Wu et al.

Anonymous Referee #1

This paper aims to assess the disagreement on EC results between the IMPROVE and the NIOSH thermal protocol and investigates the reasons for this discrepancy. The authors suggest various reconstruction methods to perform OC and EC inter-protocol data conversion with the purpose to further exploit the current OC and EC datasets. This work is certainly relevant to the scope of AMT and the methods presented are sound and in general well described. Although the manuscript is well structured some sections (section 3.2 and 3.3.2) are difficult to follow as too many figures are given both in the main manuscript and in the supplementary material. I recommend it for publication in AMT after the comments below are addressed.

Author's Response: We thank the reviewer for the constructive comments. We now divide Section 3.2 into sub sections to improve the readability, as the original one is quite long. For section 3.3.2, we have re-organized some text and rewritten a few sentences to improve the presentation clarity.

Introduction: The authors should mention that the there is no unique NIOSH protocol since many NIOSH-type protocols exist, with maximum temperatures in the inert mode found in the range 820°C ~ 900°C.

Author's Response: Thanks for the suggestion. The following text is added at the end of second paragraph of the introduction section.

Lines 58-62:
"It is worth noting that the NIOSH protocol only outlines the necessary analysis principle for operation without specifying detailed technical parameters. Therefore, a number of NIOSH-type protocols exist in the literature (Watson et al., 2005), with the peak inert mode temperatures (PIMT) varied from 850 °C to 940 °C."

Section 2.3 Please provide the exact number of valid data

Author's Response: The information is now added at the end of second paragraph of section 2.3.

Lines 141-142:
"After screening, a total of 1398 OCEC data points are used in this study."

Line 142: Also the residence time is different as the IMPROVE protocol advances from one temperature to the next one when a well-defined carbon peak has evolved

Author's Response: Following contents are added to the third paragraph of the introduction section.

Lines 72-73:
"It should be noted that the residence time is different from sample to sample as the IMPORVE protocol only advances temperature to the next step until a well-defined carbon peak has evolved."

Line 154: This is not true: In the NIOSH protocol the carbon mass evolving from 550 °C to 870 °C represents part of the OC3 peak and the OC4 peak. Equation (1) should be corrected to include the manually integrated area from 550 to 870 °C and not only the OC4 peak. The authors should explain why they have included only the OC4 peak in the equation.

Author's Response: We note that both temperature and duration of each temperature step affect the amount of OC evolved corresponding to each temperature steps (i.e., OC1, OC2, OC3, and OC4). Due to the much longer step durations in the IMPROVE protocol, carbon evolved beyond 550°C in IMPROVE protocol does not simply map to OC evolved beyond 550°C in NIOSH protocol, which includes part of OC3 and OC4). The equivalence of IMPROVE AEC and the sum of NIOSH OC4 and NIOSH AEC, as indicated by Eq. (1), is established through comparing actual data in current study (Fig. 3a showing a slope of 0.99) and a previous study of ours (Wu et al., 2012). The near unity slope seen in Fig. 3a indicates that the temperature point for establishing the equivalence was not 550°C, instead, it corresponds to the last temperature step of the protocol (i.e., 870 ^{o}C). The relevant text (lines 160-163) is re-worded and new text (lines 170-173) is added to improve the clarity.

Lines 161-164 and lines 170-172:
"The carbon fraction evolved corresponding to the 870 ℃ step is classified as OC4 in the NIOSH protocol, while in IMPROVE this fraction is evolved as part of apparent EC (AEC), which is the sum of all the EC fractions before correcting for charred OC…. It should be noted that due to the much longer step durations in the IMPROVE protocol, carbon evolved beyond 550°C in IMPROVE protocol does not simply map to OC evolved beyond the same temperature point in the NIOSH protocol (i.e., temperature step beyond 550°C, which includes part of OC3 and OC4)."

Line 172: What do you mean by thermal effect and laser effect? Both OC4 peak and PC formation depends on the aerosol chemical composition and the temperature steps and residence time in the inert mode. Correction for charring is achieved by monitoring of transmittance or reflectance.

Author's Response: The text below is added to explain thermal effect and laser effect (we now re-worded it as "optical method effect").

Lines 183-186:
"Thermal effect refers to inter-protocol EC difference caused by temperature steps difference. Optical method effect is inter-protocol EC difference introduced by PC difference between transmittance and reflectance charring correction."

Lines 201-226: I find this paragraph a bit difficult to follow. Could you please simplify it?

Author's Response: We now add two sub-section headings to Section 3.2. The text in lines 201-226 in the original manuscript has now become Section 3.2.1 (Effect of biomass burning on OC and EC determination between IMPROVE and NIOSH). We believe this restructuring has improved the clarity.

Line 255: What does RHS represent?

Author's Response: RHS has been changed to "right hand side" in the main text.

Section 3.3: As one of the objectives of this paper is to estimate the EC IMP_TOR from NIOSH TOT data it would better to include all reconstruction methods in the main manuscript

Author's Response: Suggestion taken. We now have included the description of M2-1 in the main text.

Conclusions: The authors should mention somewhere in the text that all NIOSH TOT analysis should have been done by the same analyzer otherwise other instrument specific parameters might influence the regression.

Author's Response: Suggestion taken. We add the following text in the recommendation section (section 5).

Lines 445-449:
"It should be noted that the conversion equations established in this work are based on that all the ECOC data analysis are done by the same analyzer. Other instrument specific parameters might influence the regression if multiple instruments are used in obtaining the OCEC data. For example, temperature offset has been found varied by instrument in different labs (Panteliadis et al., 2015). Oven soiling and aging has also been found to have an optical influence that introduces uncertainties to the results."

Table 1: Please include "mean" in the caption

Author's Response: Suggestion taken.